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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London 1909.)

Among other articles this number contains :—

A Summary of the ***Proceedings at the Tenth Annual Convention of the Illuminating Engineering Society (U.S.A.),*** and the ***List of Symbols, Definitions, &c.,*** prepared by the ***Committee of Nomenclature.***

An Account of the ***Visit of the Circle of Scientific, Technical, and Trade Journalists to the Universities of Leeds and Sheffield*** on Oct. 8th—10th, 1916.

THE PENNSYLVANIA LIGHTING CODE—LIGHTING OF CITY BUILDINGS—JUVENILE EMPLOYMENT—LIGHTING OF VEHICLES, &c.

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EDITORIAL.

The Visit of the Circle of Scientific, Technical, and Trade Journalists to the Universities of Leeds and Sheffield.

During the present year the Circle of Scientific, Technical, and Trade Journalists has been actively interested in the study of technical education and industrial research, and in promoting co-operation between those interested in these important subjects. It will be recalled that a very comprehensive paper was read before the Circle by Dr. William Garnett early in the year, and, as a result of the discussions which followed, an invitation was extended to the Circle by the Rt. Hon. Arthur Dyke Acland to visit the Imperial College of Science on May 31st. Mr. Acland, in addressing his guests, expressed the hope that the visit would mark the beginning of closer relations between the Universities and the Press.

The precedent set by the Imperial College has now been followed by the Universities of Leeds and Sheffield, which invited the Circle, as the

section of the Institute of Journalists chiefly interested in these matters, to form a party to visit these cities on October 8th—10th. On pp. 315-322 we give a complete account of the proceedings.

The party, who were the guests of the Universities throughout, found the visit a most enjoyable and instructive experience. An interesting feature was the series of visits to various local factories, selected to represent as far as possible industries with which the work of the Universities is associated.

In passing through the special departments of the Universities, devoted to such subjects as organic and tinctorial chemistry, leather and textile work, metallurgy, &c., all were struck by the excellent and in many respects unique facilities provided for research. It is lamentable to think that the depletion of staff and students through the war inevitably interferes with the development of much of this work; fortunately the present conditions have also opened up new opportunities for national service.

Yet these Universities, while aiming at a close connection with industry, do not lose sight of the higher fundamental elements in education, which are essential in any scheme of training intended to produce men capable of taking a broad human outlook on problems of the present day. This was particularly well illustrated by Mr. Sadler's admirable and inspiring address, in which the claims respectively of the humanities and of technical and purely scientific knowledge were balanced. Mr. Sadler showed, too, how the constitution of Leeds University, receiving endowments and funds both from the State and from local sources, is admirably adapted to the preservation of this dual aspect of education. The support of local manufacturers, authorities, and institutions, and the deep interest which they take in the welfare of the University places it in a position to do full justice to the claims of local industries; but at the same time the relation with the State enables it also to mould its courses of study so as to be adapted to broader national requirements.

On the various advisory committees which assist the work of the different departments, academic and business interests are well balanced, and such co-operation must have a beneficial influence on the work of the University. But it will be generally agreed that leading educational institutions should be free to mould their system of education without undue commercial or political control; freedom in this direction can be safeguarded by the distribution of funds so that the University is not entirely dependent on any one source of endowment.

The atmosphere of these northern cities is somehow suggestive of vast industrial activity and of new forces struggling for expression. Those who have not recently visited Sheffield, for example, can form no adequate conception of the immense area covered by the great armament firms, still spreading and expanding and producing in works standing on ground that was open fields but a few months ago. At present the energies of these firms are naturally concentrated on the production of war material, but it is obvious that after the war there will be great opportunities for their conversion to new fields of industry, and for the application on a far larger scale than at present of scientific knowledge and method.

Another thing that struck the visitors was the keen interest and pride felt by the cities of Leeds and Sheffield in the work of their Universities. In the past the support given to those institutions has been on a generous scale. We hope and believe that in the present circumstances, when there is in some quarters a tendency to "economise" over education, these

cities will live up to their past record and see that the work of the Universities is not hampered by insufficient funds, and that in the future even greater support will be available for the expansion of their valuable activities.

We notice that in the course of last year, when there seemed to be some danger of undue economies in this direction, the Universities of Manchester, Liverpool, Leeds, and Sheffield took common action, and presented to the Committee on Public Retrenchment a Memorandum summarising the activities of the Universities, expressing the hope that their work would not be allowed to suffer. We understand that the Universities are in constant touch with each other, and that their courses of study and examinations are arranged on similar lines. Doubtless such concerted effort will enable these Universities to exert a powerful influence on behalf of education. We were glad to observe that some of the leading manufacturers appreciate the advantage of securing technically trained men from the Universities. It is evident that appropriate salaries must be obtained in order to retain men of the right class, ond after the war the demand may exceed the supply.

At the present time, when we are all distracted by the war, it may be difficult to organise great extensions in technical education. But we can at least prepare public opinion for the great educational expansions that will undoubtedly become necessary after the war, and here the Scientific and Technical Press can do most valuable work. As yet the public has hardly grasped how great must be our efforts and how generous the nation's contribution to educational centres in the future if we are to make up the leeway of the past.

In dwelling on these things, however, there is no need to strike a despondent note. Conscious as we are of the vast amount that remains to be done, it is an encouragement and a stimulus to further effort to turn our eyes in directions where the good fight is making progress, and to let the country know what is being done even now in our midst. To many of the party the possibilities in the work of the Universities of Leeds and Sheffield came as a revelation. Here at least the torch of science is being kept alight, and only needs judicious replenishment to burst into new splendour after the war.

A very pleasant feature was the co-operation of the local Press, who joined in welcoming the visitors on their arrival in Leeds, and took part in the visits, and who, in their subsequent reports of the proceedings, paid a well-merited tribute to the work of the Universities. Their much-appreciated action in this respect is typical of the co-operation we should like to see established between the daily Press and their brethren in the scientific and technical sphere in keeping the important subjects of technical education and industrial research before the notice of the nation.

In conclusion, we should like to express our deep appreciation of the enterprise of the Universities in arranging this visit, and of the great amount of trouble taken by the Vice-Chancellors and the Professors in making the trip enjoyable and instructive. Everything possible was done for their comfort. A word of acknowledgment is due to Mr. Wheeler, the Secretary of Leeds University, on whom fell much of the work in making the preliminary arrangements for the visit to Leeds. Thanks are also due to the Midland Railway Co., who made special arrangements for the comfort of visitors on their journey.

Illuminating Engineering in the United States.

On pp. 305—308 we give a summary of the proceedings at the Tenth Annual Convention of the Illuminating Engineering Society in the United States. As usual the papers covered a wide variety of topics, and the Convention this year must have been rendered particularly interesting by the fact of a series of lectures on illuminating engineering being given at Pennsylvania University, and the visits to local installations arranged in connection therewith.

An interesting address was delivered by the new President, Dr. C. P. Steinmetz, who dealt with the fascinating problem of the efficiency of light production, as illustrated by modern illuminants. Future progress, Dr. Steinmetz pointed out, must lie mainly in the direction of the fuller utilisation of the principle of luminescence. A high efficiency can only be expected from processes involving the transformation of energy from a high form to a low one. In the case of solids brought to incandescence by the action of heat there is inevitably considerable loss. In those illuminants using electro-luminescence a somewhat better result may be expected, but we are still far from the theoretically attainable efficiency of 300—400 lumens per watt.

Many of the other papers and addresses dealt with practical problems. Mr. L. B. Marks, for example, referred to the tendency to greater precision in industrial lighting, as exemplified by the action of the States of Pennsylvania and New Jersey in accepting a Code of Factory Lighting, based on the provision of illumination requirements in terms of foot-candles. This enterprising action appears to be a direct result of the excellent pioneering work recently carried out by the Illuminating Engineering Society in the United States, and will no doubt be followed by other States. On p. 324 we give a summary of the Pennsylvania Code, which, in its general lines, is in close agreement with the Report of the Home Office Departmental Committee in this country.

Among the other varied subjects discussed at the Convention we notice several papers on the projection of light, and it is satisfactory to note that this subject is now receiving the attention of lighting engineers. It is not sufficiently recognised how low is the efficiency of the optical lantern, the cinematograph, and other similar apparatus. According to Mr. Chillas only about 5—8 per cent. of the light from the source actually reaches the screen. There is therefore vast room for improvement. Photometric problems also received a fair share of attention. The use of the integrating sphere has made considerable progress in the States, and its possibilities and defects are becoming better understood. It appears that such apparatus, while giving a fair measure of accuracy in skilled hands, needs to be used intelligently.

Yet another section of illuminating engineering where good work is being done is the study of brightness and its effect on the eye. The series of figures given by Mr. P. G. Nutting show how closely such results are associated with the state of adaptation of the eye—a circumstance which has perhaps hardly been sufficiently appreciated by students in the past.

We are also glad to see that the series of lectures following the Convention was well attended, and we shall look forward with interest to the printed report which will doubtless furnish a valuable record of present practice in the United States.

LEON GASTER.

NOTES ON THE TENTH ANNUAL CONVENTION OF THE ILLUMINATING ENGINEERING SOCIETY (U.S.A.).

(Held in Philadelphia, September 18th—20th, 1916.)

IN a previous issue we presented a list of the papers to be read at the Tenth Annual Convention of the Illuminating Engineering Society in the United States. In the following notes we propose to give a summary of the proceedings and of the contents of these papers. The Convention was attended by nearly 500 delegates representative of different phases of the lighting industry; special interest was aroused by the series of lectures arranged at Pennsylvania University, following immediately after the Convention, and including a tour of the chief lighting installations in the district.

PRESIDENTIAL ADDRESS.

After a welcome had been accorded to the visitors by Mr. E. B. Cattell, chief city statistician of Philadelphia, an address was delivered by Dr. C. P. Steinmetz, the new president. Dr. Steinmetz, in summarising recent progress in illuminants, expressed the view that the most hopeful prospect of approaching the ideal efficiency, computed at 300—400 lumens per watt, lay in the utilisation of luminescence. The luminous arc, with an efficiency of approximately 100 lumens per watt (0·12 watts per candle), furnished one of the best examples of such an illuminant. In general a high efficiency could only be anticipated if energy were transformed from a high form to a low one. If one relied on the converse operation, as in the case of solids heated to incandescence where heat is converted into light, the process was invariably comparatively inefficient.

Dr. Steinmetz also described some of the investigations now in progress with a view to obtaining still higher efficiencies from the luminous arc. These include a survey of the spectra of the vapour of all known elements, under varied conditions of electrode temperature and pressure. Most of our present information is based on phenomena which take place at ordinary atmospheric pressure; but it is well known that marked variations occur when the pressure is greatly increased or diminished. For example, the mercury vapour lamp, whose ordinary predominant tone is green, becomes pinkish when superheated mercury is used, and violet at very low temperatures and pressures.

As an instance of other possible directions of research, Dr. Steinmetz mentioned the luminescence of willemite under cathode bombardment; in electroluminescence the physicist has an energy-conversion of the highest efficiency but a really satisfactory method of applying the exciting energy has still to be obtained.

REPORT ON PROGRESS.

The usual report is presented by the Committee on Progress, occupying 60 pages of densely-printed matter. A list of symbols and definitions of terms used in illuminating engineering has been prepared by the Committee of Nomenclature and Standards. These are reproduced on pp. 309—313 in this issue.

PROJECTION PROBLEMS.

Two papers, by J. A. Orange and R. B. Chillas, deal with the designs of apparatus for optical projection, such as the searchlight and the magic lantern. The formula for the illumination of the screen is as follows:—

$$I=\frac{B.A}{x^2}.k,$$

where B is the intrinsic brilliancy of the

source, A the apparent opening of the objective, x the distance of projection and k the coefficient of transmission of the system. From this it is apparent that the most important factor in the source of light is high intrinsic brightness. The coefficient of transmission of the system is exceedingly low. R. B. Chillas estimates that only 10—12 per cent. of the light yielded by the arc crater strikes the condenser in the lantern, and that the percentage of the original light reaching the screen is under 5—8 per cent. In a searchlight, using a parabolic mirror, on the other hand, about 60 per cent. of the total flux of light is received by the mirror. He therefore asks whether elliptical mirrors, with the source at one focus and the objective at the other, could not be used for lantern projection, believing that a higher efficiency might conceivably be obtained in this way.

In practice it is necessary to compromise between the best arrangements of lens and source. One may :—

(1) Use a very small objective, an ordinary condenser and a powerful and expensive source.

(2) Use a small objective, an expensive condenser and a small cheap source of light.

(3) Use an objective which has a gross aperture in excess of the effective aperture for any field point, a cheap condenser, and a relatively small and cheap source.

Mr. Orange summarises the figures so far given for the illumination of cinematograph screens ; 2·5 ft.-candles seems a desirable figure.

A paper by H. P. Gage, on " Coloured Glass in Illuminating Engineering," contains some curves showing the distribution of light in the spectrum from typical glasses of so-called pure colours (red, green, &c.). A reference is also made to glass for the obstruction of ultra-violet light, fluorescing glass, and amber glass to relieve eyestrain. It is sometimes held that the latter glass improves acuity of vision, but the author prefers the full spectrum of white light. An " artificial daylight " screen for use with the half-watt lamp is now available ; this is stated to transmit about 15 per cent. of light.

PHOTOMETRY WITH THE INTEGRATING SPHERE.

An interesting paper was read by F. A. Benford on " The Integrating Sphere and a New Type of Compensating Screen." It is pointed out that in an integrating sphere errors are caused by the presence of " foreign bodies " such as the screens inserted to protect the observation window from the direct rays of the lamp tested or from the calibrating source. Errors may also be caused by the absorption of light by the actual lamp tested. These errors are most observable with spheres of small diameter ; when the diameter attains two metres or over they are of less account. The author suggests a special form of screen to compensate these effects. This consists of a small convex mirror, with the reflecting surface facing the window, whose position is so adjusted that the hemisphere in which the window is located is now entirely visible from the window ; there are thus two distinct paths by which rays from the interior surface of the sphere reach the window : (a) directly, and (b) by reflection from the convex mirror. A refinement which adds to the efficacy of the device consists in painting sections of the mirror-surface with black paint. In this way, it is claimed, the errors due to foreign bodies are diminished and the effect of unsymmetrical distribution of light from the source tested is much less noticeable.

FORCED LIFE TESTS.

L. J. Lewinson discusses the value of forced life tests on incandescent lamps, *i.e.*, tests in which the lamps are intentionally run at a higher efficiency than normal so that the diminution in candle-power takes place more quickly. Such tests lead to a considerable saving in time but have to be made as carefully as ordinary life tests. It is known that the results by forced and ordinary life tests can be related thus :—

$$\frac{\text{Life}_1}{\text{Life}_2}=\left(\frac{\text{lumens per watt}_2}{\text{lumens per watt}_1}\right)^b$$

The exponent b was assumed prior to 1914 to have the value 6·65, but this does not appear to apply to all types of lamps and the author, as a result of extensive tests, presents figures varying from 5·6

to 8.2. There is a general tendency towards a lower component for lamps of smaller sizes. The errors involved in assuming a fixed exponent are represented in a diagrammatic form.

Brightness Relations.

Several papers dealing with "brightness" in various aspects were read. P. G. Nutting, in his paper on "Brightness and Contrast in Vision," analyses the conditions over the whole range of brightness, the three most important factors being: (1) the lowest perceptible brightness, (2) the faintest perceptible contrast, and (3) the highest comfortable brightness.

These data are conveniently assembled in tabular form thus:—

	Brightness of Field (millilamberts).	Difference Fraction.	Discrimination Factor.	Threshold Limit (millilamberts).	Glare Limit (millilamberts).
	0·000001	(1·00)	1·0	0·00000093	20·1
	0·00001	(0·66)	1·5	0·0000042	40·7
	0·0001	0·395	2·5	0·000019	89·0
Exteriors at night	0·001	0·204	4·5	0·000087	186·0
	0·01	0·078	12·8	0·00039	400·0
Interiors at night	0·1	0·370	27·0	0·00174	810·0
					Lamberts.
	1·0	0·0208	48·2	0·0081	1·66
Interiors by day	10·0	0·0174	57·5	0·036	3·47
	100·0	0·0172	58·1	0·28	7·25
Exteriors by day	1000·0	0·0240	41·7	2·15	14·45
	10000·0	(0·048)	(20·9)	(232·0)	30·90

One of the most important quantities is the "Discrimination factor," defined as the field brightness divided by the just noticeable brightness (B/dB). It is seen that this reaches a maximum value of 50—60 as the brightness rises; but after a certain point glare sets in and the figure begins to fall again. Similarly, the order of brightness which causes perceptible glare (glare limit) and the least brightness which the eye can detect as light (threshold limit) continuously rise as the eye becomes adapted to each rising step in the general brightness level. L. T. Troland, in "Apparent Brightness: its Conditions and Properties," points out that while a fair measure of precision has been reached in determining the objective brightness of surfaces, no one has yet been able to solve the complexities involved in the problem of measuring the subjective brightness, *i.e.*, the brightness of an object as the mind actually conceives it. The "retinal brightness" depends on at least 30 different factors. An interesting curve is shown by the author connecting the duration of a retinal "after-image" with the period of pre-exposure. In view of the suggestion that the study of such images might furnish a method of estimating glare, this curve is of interest.

Another aspect of the problem is attacked by F. C. Caldwell, who has made the experiment of changing from direct to indirect light (the observer meantime having his eyes closed) and then asking for a judgment whether the illumination is greater or less in one case than the other. While the results are mainly inconclusive, it is interesting to note that five out of seven observers asked for a higher actual illumination by the indirect lighting than by the direct lighting, in order to get the same mental effect.

Dr. C. E. Ferree and Miss G. Rand, whose previous papers have been concerned with the effect of gradation of brightness in the field of vision, give the results of some experiments on a series of six reflectors of various densities; these serve to confirm the views previously expressed as to the effect of bright surfaces on clearness of vision.

Bowls and Reflectors.

J. L. Stair and J. A. Hoeveler emphasise the value of upper reflectors in connection with translucent bowls—especially in

modifying the distribution of light and diminishing the glare that would otherwise be obtained from half-watt lamps. H. W. Jenkins and G. W. Roosa ("Recent Developments in Prismatic Glassware") likewise referred to the development of glassware for these lamps, special attention being called to the latest bowls of a decorative type.

MISCELLANEOUS.

A very interesting report is presented on the Lighting of the Cleveland Museum of Art by "artificial daylight" units. S. G. Hibbenal analyses the costs of lighting a large office, dealing incidentally with the problem of illuminating elevators. C. S. Snyder and F. H. Gilpin describe the gas-lighting of the Philadelphia Civic Exhibition, a feature of which was the extreme uniformity of the illumination obtained, while C. H. French and C. J. van Gieson advocate the adoption of a combination of gas and electric lighting in the home, the best method of dealing with halls, dining and drawing rooms, bedrooms, &c., and other typical rooms being discussed in detail.

CONDITIONS OF ILLUMINATION IN NEW YORK BUILDINGS.

In the exhaustive inquiries which have been made by many social workers into the conditions in tenements and large city buildings, one has often been struck by the absence of any data regarding the lighting conditions. It is therefore interesting to note in a recent bulletin issued by the Department of Health in New York, an account of an inspection of a large block of buildings in that city, which included an inquiry into the conditions of illumination. It is remarked that in the offices visited as many as 85·33 per cent. of the employees worked by artificial light (it seems to be implied *exclusively* by artificial light). The proper arrangement of the illumination is therefore a matter of importance.

The inspector (Dr. Marion B. McMillan) was struck by the fact that, while æsthetic effects in lighting were evidently the subject of much study and great skill was sometimes shown in the application of expensive lighting fittings, very little attention had been given to *the physiological effect of the illumination.* The amount of illumination varied from 0·5 to over 40 ft.-candles; there appeared to be no recognised standard although the requirements in different offices were apparently substantially the same. It was considered that for type writing and book-keeping as much as 8—9 foot-candles was desirable, the best results being obtained from desk-lights, well shaded and placed about 19 inches from the work. There is evidence that very much higher illuminations, such as occur when 40 and 60 watt lamp local lamps are used for desk lighting, affected the eyes prejudicially. Cases are recorded in which the use of glasses began when the workers first began to do their work by artificial light. An interesting case was that of a bookkeeper who suffered from headaches which were traced to the excessive illumination (about 18 ft.-candles). When this was reduced to 7 ft.-candles the headaches disappeared.

The concentration of light on a small area, with comparatively dark surroundings, is regarded as highly prejudicial and local lighting requires to be used with care.

It can hardly be doubted that a similar inspection of offices in this city would be productive of similar comments. At the present time, when economy in lighting is being urged on national grounds, this matter may be commended to the notice of the medical profession.

SYMBOLS, TERMS, AND DEFINITIONS USED IN ILLUMINATING ENGINEERING.

Presented by the Committee on Nomenclature of the Illuminating Engineering Society, U.S.A., September 18th, 1916.

Definitions.

1. **Luminous Flux** is radiant power evaluated according to its visibility; *i.e.*, its capacity to produce the sensation of light.

2. **The visibility,** K_λ of radiation, of a particular wave-length, is the ratio of the luminous flux to the radiant power producing it.

3. **The mean value of the visibility,** K_m, over any range of wave-lengths, or for the whole visible spectrum of any source, is the ratio of the total luminous flux (in lumens) to the total radiant power (in ergs per second, but more commonly in watts).

4. **The luminous intensity,** I, of a point source of light is the solid angular density of the luminous flux emitted by the source in the direction considered; or it is the flux per unit solid angle from that source.

Defining equation:

$$I=\frac{dF}{d\omega}$$

or, if the intensity is uniform,

$$I=\frac{F}{\omega},$$

where ω is the solid angle.

5. Strictly speaking no point source exists, but any source of dimensions which are negligibly small by comparison with the distance at which it is observed may be treated as a point source.

6. **Illumination,** on a surface, is the luminous flux-density on that surface, or the flux per unit of intercepting area.

Defining equation:

$$E=\frac{dF}{dS},$$

or, when uniform,

$$E=\frac{F}{S},$$

where S is the area of the intercepting surface.

7. **Candle**—the unit of luminous intensity maintained by the national laboratories of France, Great Britain, and the United States.*

8. **Candlepower**—luminous intensity expressed in candles.

9. **Lumen**—the unit of luminous flux, equal to the flux emitted in a unit solid angle (steradian) by a point source of one candlepower.†

10. **Lux**—a unit of illumination equal to one lumen per square meter. The cgs. unit of illumination is one lumen per square centimeter. For this unit Blondel has proposed the name "Phot." One millilumen per square centimeter (milliphot) is a practical derivative of the cgs. system. One foot-candle is one lumen per square foot and is equal to 1·0764 milliphots.

The milliphot is recommended for scientific records.

11. **Exposure**—the product of an illumination by the time. Blondel has proposed the name "phot-second" for the unit of exposure in the cgs. system. The microphot second (0·000001 phot-second) is a convenient unit for photographic plate exposure.

12. **Specific luminous radiation,** E'—the luminous flux-density emitted by a surface, or the flux emitted per unit of

* This unit, which is used also by many other countries, is frequently referred to as the international candle.

† A uniform source of one candle emits 4π lumens.

emissive area. It is expressed in lumens per square centimeter.

Defining equation:

For surfaces obeying Lambert's cosine law of emission,

$$E' = \pi b_0.$$

13. Brightness, b, of an element of a luminous surface from a given position, may be expressed in terms of the luminous intensity per unit area of the surface projected on a plane perpendicular to the line of sight, and including only a surface of dimensions negligibly small in comparison with the distance at which it is observed, It is measured in candles per square centimeter of the projected area.

Defining equation:

$$b = \frac{dI}{dS \cos \theta}.$$

(where is the angle between the normal to the surface and the line of sight.)

14. Normal brightness, b_0, of an element of a surface (sometimes called specific luminous intensity) is the brightness taken in a direction normal to the surface.*

Defining equation:

$$b_0 = \frac{dI}{dS},$$

or, when uniform,

$$b_0 = \frac{I}{S}.$$

15. Brightness may also be expressed in terms of the specific luminous radiation of an ideal surface of perfect diffusing qualities, *i.e.*, one obeying Lambert's cosine law.

16. Lambert—the cgs. unit of brightness—the brightness of a perfectly diffusing surface radiating or reflecting one lumen per square centimeter. This is equivalent to the brightness of a perfectly diffusing surface having a coefficient of reflection equal to unity and an illumination of one phot. For most purposes, the millilambert (0·001 lambert) is the preferable practical unit.

A perfectly diffusing surface emitting one lumen per square foot will have a brightness of 1·076 millilamberts.

Brightness expressed in candles per square centimeter may be reduced to lamberts by multiplying by $\pi = 3{\cdot}14$.

Brightness expressed in candles per square inch may be reduced to foot-candle brightness by multiplying by the factor $144\pi = 452$.

Brightness expressed in candles per square inch may be reduced to lamberts by multiplying by $\pi/6{\cdot}45 = 0{\cdot}4868$.

In practice, no surface obeys exactly Lambert's cosine law of emission; hence the brightness of a surface in lamberts is, in general, not numerically equal to its specific luminous radiation in lumens per square centimeter.

Defining equations:

$$L = \frac{dF}{dS},$$

or, when uniform,

$$L = \frac{F}{S}.$$

17. Coefficient of reflection—the ratio of the total luminous flux reflected by a surface to the total luminous flux incident upon it. It is a simple numeric. The reflection from a surface may be regular, diffuse, or mixed. In perfect regular reflection, all of the flux is reflected from the surface at an angle of reflection equal to the angle of incidence. In perfect diffuse reflection the flux is reflected from the surface in all directions in accordance with Lambert's cosine law. In most practical cases there is a superposition of regular and diffuse reflection.

18. Coefficient of regular reflection is the ratio of the luminous flux reflected regularly to the total incident flux.

19. Coefficient of diffuse reflection is the ratio of the luminous flux reflected diffusely to the total incident flux.

Defining equation:

Let m be the coefficient of reflection (regular or diffuse).

Then, for any given portion of the surface,

$$m = \frac{E'}{E}.$$

* In practice, the brightness b of a luminous surface or element thereof is observed and not the normal brightness b_0. For surfaces for which the cosine law of emission holds, the quantities b and b_0 are equal.

20. Lamp—a generic term for an artificial source of light.

21. Primary luminous standard—a recognised standard luminous source reproducible from specifications.

22. Representative luminous standard—a standard of luminous intensity adopted as the authoritative custodian of the accepted value of the unit.

23. Reference standard—a standard calibrated in terms of the unit from either a primary or representative standard and used for the calibration of working standards.

24. Working standard—any standardised luminous source for daily use in photometry.

25. Comparison lamp—a lamp of constant but not necessarily known candlepower against which a working standard and test lamps are successively compared in a photometer.

26. Test lamp, in a photometer—a lamp to be tested.

27. Performance curve—a curve representing the behaviour of a lamp in any particular (candlepower, consumption, &c.) at different periods during its life.

28. Characteristic curve—a curve expressing a relation between two variable properties of a luminous source, as candlepower and volts, candlepower and rate of fuel consumption, &c.

29. Horizontal distribution curve—a polar curve representing the luminous intensity of a lamp, or lighting unit, in a plane perpendicular to the axis of the unit, and with the unit at the origin.

30. Vertical distribution curve—a polar curve representing the luminous intensity of a lamp, or lighting unit, in a plane passing through the axis of the unit and with the unit at the origin. Unless otherwise specified, a vertical distribution curve is assumed to be an average vertical distribution curve, such as may in many cases be obtained by rotating the unit about its axis, and measuring the average intensities at the different elevations. It is recommended that in vertical distribution curves, angles of elevation shall be counted positively from the nadir as zero, to the zenith as 180°. In the case of incandescent lamps, it is assumed that the vertical distribution curve is taken with the tip downward.

31. Mean horizontal candlepower of a lamp—the average candlepower on the horizontal plane passing through the luminous centre of the lamp.

It is here assumed that the lamp (or other light source) is mounted in the usual manner, or, as in the case of an incandescent lamp, with its axis of symmetry vertical.

32. Mean spherical candlepower of a lamp—the average candlepower of a lamp in all directions in space. It is equal to the total luminous flux of the lamp in lumens divided by 4π.

33. Mean hemispherical candlepower of a lamp (upper or lower)—the average candlepower of a lamp in the hemisphere considered. It is equal to the total luminous flux emitted by the lamp in that hemisphere divided by 2π.

34. Mean zonal candlepower of a lamp—the average candlepower of a lamp over the given zone. It is equal to the total luminous flux emitted by the lamp in that zone divided by the solid angle of the zone.

35. Spherical reduction factor of a lamp—the ratio of the mean spherical to the mean horizontal candlepower of the lamp.*

36. Photometric tests in which the results are stated in candlepower should be made at such a distance from the source of light that the latter may be regarded as practically a point. Where tests are made in the measurement of lamps with reflectors, or other accessories at distances such that the inverse square law does not apply, the results should always be given as "apparent candlepower" at the distance employed, which distance should always be specifically stated.

* In the case of a uniform point-source, this factor would be unity, and for a straight cylindrical filament obeying the cosine law it would be $\pi/4$.

The output of all illuminants should be expressed in lumens.

37. Illuminants should be rated upon a lumen basis instead of a candlepower basis.

38. The specific output of electric lamps should be stated in terms of lumens per watt and the specific output of illuminants depending upon combustion should be stated in lumens per British thermal unit per hour. The use of the term " efficiency " in this connection should be discouraged.

When auxiliary devices are necessarily employed in circuit with a lamp, the input should be taken to include both that in the lamp and that in the auxiliary devices. For example, the watts lost in the ballast resistance of an arc lamp are properly chargeable to the lamp.

39. The specific consumption of an electric lamp is its watt consumption per lumen. " Watts per candle " is a term used commercially in connection with electric incandescent lamps, and denotes watts per mean horizontal candle.

40. Life tests—Electric incandescent lamps of a given type may be assumed to operate under comparable conditions only when their lumens per watt consumed are the same. Life test results, in order to be compared must be either conducted under, or reduced to, comparable conditions of operation.

41. In comparing different luminous sources, not only should their candlepower be compared, but also their relative form, brightness, distribution of illumination and character of light.

42. Lamp accessories.—**A reflector** is an appliance the chief use of which is to redirect the luminous flux of a lamp in a desired direction or directions.

43. A shade is an appliance the chief use of which is to diminish or to interrupt the flux of a lamp in certain directions where such flux is not desirable. The function of a shade is commonly combined with that of a reflector.

44. A globe is an enclosing appliance of clear or diffusing material the chief use of which is either to protect the lamp or to diffuse its light.

Photometric quantity.	Name of unit.	Symbols and defining equations.	Abbreviation for name of unit.
1. Luminous flux	Lumen	F. Ψ	l
2. Luminous intensity	Candle	$I=\frac{dF}{d\omega}$, $\Gamma=\frac{d\Psi}{d\omega}$	cp.
3. Illumination	Phot, foot-candle, lux	$E=\frac{dF}{dS}=\frac{I}{r^2}\cos\theta.\beta$	ph. fc.
4. Exposure	Phot-second Micro phot-second	Et	phs. μphs.
5. Brightness	Apparent candle per sq. cm. Apparent candle per sq. in.	$b=\frac{dI}{dS\cos\theta}$	—
	Lambert	$L=\frac{dF}{dS}$	—
6. Normal brightness	Candles per sq. cm. Candles per sq. in.	$b_0=\frac{dI}{dS}$	—
7. Specific luminous radiation	Lumens per sq. cm. Lumens per sq. in.	$E'=\pi b_0$, β'	—
8. Coefficient of reflection	—	$m=\frac{E}{E}$	—

45. Photometric Units and Abbreviations

9. Mean spherical candlepower scp.
10. Mean lower hemispherical candlepower lcp.
11. Mean upper hemispherical candlepower ucp.
12. Mean zonal candlepower zcp.
13. Mean horizontal candlepower mhcp.
14. 1 lumen is emitted by 0·07958 spherical candlepower.
15. 1 spherical candlepower emits 12·57 lumens.
16. 1 lux=1 lumen incident per square meter=0·0001 phot=0·1 milliphot.
17. 1 phot=1 lumen incident per square centimeter=10,000 lux=1,000 milliphots=1,000,000 microphots.
18. 1 milliphot=0·001 phot=0·929 foot-candle.
19. 1 foot-candle=1 lumen incident per square foot=1·076 milliphots=10·76 lux.
20. 1 lambert=1 lumen emitted per square centimeter of a perfectly diffusing surface.
21. 1 millilambert=0·001 lambert.
22. 1 lumen, emitted, per square foot*=1·076 millilamberts.
23. 1 millilambert=0·929 lumen, emitted, per square foot.*
24. 1 lambert=0·3183 candle per square centimeter=2·054 candles per square inch.
25. 1 candle per square centimeter=3·1416 lamberts.
26. 1 candle per square inch=0·4868 lambert=486·8 millilamberts.

46. Symbols.—In view of the fact that the symbols heretofore proposed by this committee conflict in some cases with symbols adopted for electric units by the International Electrotechnical Commission, it is proposed that where the possibility of any confusion exists in the use of electrical and photometrical symbols, an alternative system of symbols for photometrical quantities should be employed. These should be derived exclusively from the Greek alphabet, for instance :—

Luminous intensity	Γ.
Luminous flux	Ψ.
Illumination	β.

* Perfect diffusion assumed.

JUVENILE EMPLOYMENT.

Attention has recently been drawn to the admirable researches carried out under the supervision of the Committee on the Health of Munition Workers on the relations between hours of work and fatigue.

In a recently issued Bulletin (No. 13) the conditions of juvenile labour in factories is discussed. It is pointed out that many factors that have a depressing effect on workers generally have a specially bad effect on children. Expressions of opinion of factory inspectors are quoted to the effect that in many workshops children are being seriously overworked. Continued long hours give rise to a condition of general lassitude, dullness, and weariness that must have a prejudicial effect alike on the work and the health of the children. It is strongly advised that in no case should boys under 16 work for more than 60 hours a week. Eight hours of sleep are the minimum.

The seriousness of the matter lies in the fact that overworking of children appears to be so widespread. If one had only to deal with a few isolated cases, the result of temporary pressure, one might hope that a little perseverance on the part of inspectors would put things right. But the large number of instances commented on in the Report suggests that many employers in the country do not yet realise that these excessive hours are uneconomical and inhuman.

Equally important is the general care of children to whom the general supervision and guidance of older people is often essential. Facilities for recreation can do much to prevent staleness and fatigue. An interesting account is given of the work of Boy Visitors, who appear to be doing a most valuable work in supervising the well-being of juvenile workers and remedying conditions that may lead to permanent deterioration in physique.

The Committee is doing a national service in drawing public attention to this matter, and we hope they will persevere in their much-needed educational campaign.

Mr. H. Cornish	Mr. J. Sykes	Prof. J. W. Cobb	Mr. P. N. Hasluck	Mr. M. E. Sadler	Mr. L. Gaster	Mr. A. J. Mundella	Mr. Sydney Walton
(Cons. Secretary of the Institute of Journalists.)	*(Past-President of the Institute of Journalists.)*	*(Dept. of Coal Gas and Fuel Industries, Leeds University.)*	*(Hon. Treas. and Sec. of the Circle.)*	*(Vice-Chancellor of Leeds University.)*	*(Chairman of the Circle.)*	*(Chairman of the Lond. District, Institute of Journalists.)*	*(Welfare Dept., Ministry of Munitions.)*

Photograph taken outside the Hotel Metropole, Leeds, following the gathering of the Leeds Luncheon Club, on the occasion of the Visit of the Circle of Scientific, Technical, and Trade Journalists, Oct. 9th, 1916.

A VISIT TO THE UNIVERSITIES OF LEEDS AND SHEFFIELD.

(An account of a visit to the Universities of Leeds and Sheffield, and to various factories in these cities by the Circle of Scientific, Technical and Trade, Journalists, Oct. 8th—10th, 1916.)

In recent issues of this journal reports have been published of discussions at several meetings of the Circle of Scientific, Technical, and Trade Journalists, on the subject of Technical Education and Industrial Research. Following these discussions an invitation was given to members of the Circle and friends to visit the Imperial College of Science on May 31st, the object of this visit being to promote closer relations between the Universities and the scientific and technical Press, and to assist the latter in bringing about a fuller public appreciation of the benefits of technical education and industrial research.

The precedent of the Imperial College of Science has now been followed by the Universities of Leeds and Sheffield, who invited the circle of Scientific, Technical, and Trade Journalists, as the section of the Institute of Journalists chiefly interested in these matters, to visit these two cities on October 8th—10th. Throughout their stay the visitors were the guests of the Universities, and besides hearing something of their work, were afforded opportunities of seeing some of the factories most closely associated with their educational programme.

The party consisted of:—

Mr. F. Bourne Newton ‡ (*Caterer*), Mr. H. Cornish* (Cons. Sec. of the Inst. of Journalists (*School Government Chronicle*), Mr. A. T. Dale ‡ (*Plumber and Decorator*), Mr. E. Davis† (*Chemical Trade Review and Chemical Engineer*, &c.), Mr. J. S. Dow,‡ Mr. E. L. Dodd† (*Canadian Machinery and Manufacturing News*, &c.), Mr. L. Gaster*‡ (Chairman of the Circle of Scientific Tech. and Trade Journalists, *Illuminating Engineer*), Mr. Gilbert Wood*‡ (Vice-President of the Inst. of Journalists and ex-Chairman of the London District, *Architect and Contract Reporter*), Mr. J. L. Greaves † (*Stationery World*, &c.), Mr. Hartley Aspden,* Mr. P. N. Hasluck*‡ (Treasurer of the Circle of Scientific, Tech. and Trade Journalists), Mr. A. S. Jennings‡ (*Decorator*), Mr. F. Marshall† (*Power User*, &c.), Mr. A. J. Mundella* (Chairman of the London District of the Inst. of Journalists), Mr. H. E. Philpott (*Illustrated Carpenter and Builder*), Mr. S. C. Phillips† (*Paper Maker*, &c.), Mr. S. Rentell (*Electricity*), Mr. M. Ross (*Times Engineering Supplement*), Mr. Chambers Smith (*Municipal Engineering and the Sanitary Record*), Mr. G. Springfield* (Mem. Executive Committee of the Inst. of Journalists), Mr. J. Sykes* (Past-President of the Inst. of Journalists), Mr. W. A. Standring† (*Motor Cycle*, &c.), Dr. S. A. Vasey (*Lancet*), and Mr. Sydney Walton (Ministry of Munitions, Welfare Dept.).

Mr. Gilbert Wood, Mr. G. Springfield, and Mr. M. Ross were unable to be present at Leeds and joined the party at Sheffield. Dr. R. A. Gregory (*Nature*) and Mr. Pendred (*Engineer*), while expressing their interest in the visit, were prevented by editorial duties from being present. Mr. E. J. P. Benn (*Hardware Trade Journal*, &c.), Mr. H. Val Fisher (*Advertising World*), Mr. F. Hinde (Chairman of the Executive Committee of the Inst. of Journalists), Mr. Harold Jeans (*Iron and Coal Trades Review*), Mr. T. C. Elder (*Engineering Review*), and Mr. A. J. Meyjes (*Ironmonger*) sent messages of

* Fellow of the Institute of Journalists.
† Representing the British Association of Trade and Technical Journalists.
‡ Member of the Committee of Scientific, Technical, and Trade Journalists.

regret at being unable, at the last moment, to join the party, owing to pressure of work.

Among others, the following journals made arrangements to be represented either by members of the party or through local representatives:—*Nature*, *The Engineer*, *The Electrician*, *The Journal of Gas Lighting*, and *The Gas World*, &c.

The party arrived at Leeds on the night of October 8th, and were received at the Queen's Hotel by Mr. M. E. Sadler, Vice-Chancellor of the University of Leeds. A number of local journalists were present at the reception and joined in welcoming the visitors, among those who spoke being Mr. Phillips (*Yorkshire Post*), Mr J. Sykes (Fellow and Past-President of the Inst. of Journalists), Mr. Kenyon (*Yorkshire Observer*), Mr. Raynes (*Leeds Weekly Citizen*), Mr. Outhwaite (*Leeds Mercury*), and Mr. Edge (*Yorkshire Herald*). Mr. L. Gaster (Fellow Inst. Jour., Chairman of the Circle) replied for the visitors.

Visit to Leeds University.

On the following morning the party made their way to the University, where they were again joined by some of the local journalists. They were received in the Great Hall by Mr. Sadler, who delivered a most interesting and inspiring address, of which the following is a summary:—

Address by Mr. M. E. Sadler, Vice-Chancellor of Leeds University.

It is incumbent upon all Universities to endeavour to be of service to industry. Old and new they face this obligation. The ever-increasing importance of industry in modern life makes it incumbent upon Universities to give a suitable training to those who intend to follow an industrial career. The applications of science to industrial operations make it natural and inevitable that there should be intimate connection between industrial needs and the University Laboratories. And the importance of emphasising its human side in all industrial undertakings brings about a close relation between the factory and parts of its University courses (training in the humanities) which to a superficial view might seem remote.

The modern Universities, set in industrial districts and drawing their undergraduates in great measure from families which are concerned in industrial enterprise, were naturally quick to feel the new obligation. At Leeds, we have been greatly helped by the counsels of the Advisory Committees, attached to each of our technological and to some of our professional departments. In the study of the Textile Industries, and of Colour Chemistry and Dyeing, for example, in the departments which the University owes to the munificence and foresight of the Clothworkers' Company, the Advisory Committee, representative of the business experience of the Textile Trades, gives us practical guidance. The same is true of the Advisory Committees attached severally to the Department of Coal Gas and Fuel Industries (in which the University has received most valuable assistance and support from the Institution of Gas Engineers), to the Mining Department (in connection with which indispensable help has been given by the Drapers' Company and by the West Yorkshire Coal Owners' Association), to the Department of the Leather Industries (which is indebted to the constant aid and advice of the Leather Industries Federation), to the Department of Agriculture (which is advised by the Yorkshire Council for Agricultural Education), and to the Civil, Mechanical, and Electrical Engineering Departments. These Advisory Committees report to the University Council, which is the executive body of the University. Their members give their services voluntarily. Through them the University is kept in close touch with the practical and scientific experience of the various branches of industry. On each Committee, in order that there may be interchange of view and harmony of action, the academic element is sufficiently represented. The University Court, the supreme authority, is fully representative of business as well as of academic experience. The aim is to secure at every point a fusion between different types of knowledge and a co-ordination of effort in the furtherance of education and of scientific research.

Thus representative of the different elements in the modern social structure, the University is by Charter autonomous. Its income—about £70,000 a year—falls into three parts. One-third comes from endowments and fees; a third (a large third) from Government grants received from the Treasury, the Board of Education, and the Board of Agriculture; and a third (a small third) from grants from the County Councils of Yorkshire, in West, East, and North Ridings, and from the County Boroughs of Leeds and Wakefield. Stability, progress, and a sense of responsibility on the part of the University Authorities (including its Advisory Committees) are enhanced by this balance of financial support. The University is, and should be, in very intimate touch with the Government; but it would be undesirable for the State Departments to be the sole source from which the University funds are drawn. Such an arrangement would put too much control in the hands of distant bodies of officials who, though animated by a high spirit of public service, are somewhat remote from the ever-developing needs of industry and not omniscient about the requirements of education and research. Similarly the connection between the University and the Local Authorities is very intimate. They act in close co-operation, for the good of the districts which they serve. By personal interview, letter, and telephone they are in constant communication. The work of both is carefully related. But it would be inexpedient if the policy of the University were framed in the absolute control of the Local Authorities which, well-informed of many local needs, are not necessarily in a position to judge what should be done by the University in the National and Imperial interest.

The effectiveness of the work of the University depends in the last resort (granted adequate equipment and resources) upon the spirit of its personnel. This is the vital thing. It must be inspired by a disinterested zeal for knowledge, for truth, and for service. It must combine deference to outside experience with a sturdy independence of judgment, courage, and tact; the concentrated passion for research with the unselfishness of the teacher; intellectual ardour with practical good sense. And it is found where all branches of the University's work are in some degree interdependent. The need for strengthening the human side in all individual effort makes the humanistic side of the University studies increasingly valuable to the scientific and to the technological. The reality of the scientific and technological studies helps the humanities in focussing its work upon definite aims conducive to the welfare of the community which it endeavours to serve.

The visitors were then conducted over the building by the professors of the various departments, many of which are unique. To technical journalists the varied character of several of the more technical departments, which are closely related to the industries of Yorkshire, was specially interesting. The School of Chemistry and Applied Chemistry is very widely known; the School of Agriculture is stated to be the largest but one in the United Kingdom, and the Departments of Colour Chemistry and Textile Industries are regarded as the best in Western Europe. All courses are open equally to men and women.

Department of Organic Chemistry.

The first department visited was that dealing with Organic Chemistry, where the party were received by Professor J. B. Cohen, B.Sc., Ph.D., F.R.S. This department has done useful service in connection with the war, especially in the production of many drugs hitherto imported from abroad. Since the outbreak of war a variety of compounds needed by the medical profession have been prepared and sent out from the University, including the chloramines, a cheap and effective hypochlorite antiseptic, and novocaine and eucaine, now largely employed as local anæsthetics.

Leather Department.

Passing on to the Leather Department, the visitors were met by Professor Procter, D.Sc., F.I.C., who explained some of the interesting processes developed in the

University Laboratories. In the ordinary course many investigations of value to the trade are carried on; there is plant for manufacture, on a small scale, of all kinds of leathers; a museum with an extensive collection of raw materials and products of leather manufacture; and a laboratory in which students are trained in the chemical methods employed in the control of processes and the detection of faults. In the bacteriological laboratory culture-media required by the hospitals for the isolation and detection of disease germs are being prepared, and a series of special investigations are being conducted for the War Office. One object of great interest to the visitors was a machine by which the superficial area of any piece of leather can be measured in a few seconds, and we understand that this has proved very useful for checking deliveries. Visitors were also shown the research laboratory erected by the leather industries of the world in recognition of Professor Procter's services to the leather trade, where investigations are being conducted on colloids, a class which includes almost all the raw materials of leather manufacture, and has important chemical and physiological applications.

Department of Textile Industries.

The party were then shown over the Department of Textile Industries by Professor A. F. Barker, M.Sc.; all were much impressed by the excellent equipment and organisation of this section of the University. During the past year important researches have been undertaken on the fabrics for airships and aeroplanes, and the clothing supplied to troops at the Front. These included a series of tests on the comparative cost and efficiency of British and German Army cloths—a comparison which, we were informed, fully justified the view that the British material is superior and less costly. Experiments are also in progress on the electrification of textile fibres, carbonising and finishing, the preparation of colour dyestuffs for colour sensitisation. An investigation into the growth and treatment of flax is being carried out by the University at Selby, and is closely associated with the Textile, Agricultural, and other Departments.

Colour Chemistry and Dyeing.

In the Department of Colour Chemistry and Dyeing, Professor A. G. Perkin, F.R.S., F.I.C., described some of the important work carried on in relation to the production of dyes, of which this country has been in sore need since war broke out. British Dyes, Ltd., have secured a laboratory in the University for the use of certain of their research chemists, under the supervision of the Professor of the department—a form of co-operation between University and factory which cannot but be beneficial. Visitors were shown a great variety of colour-materials entirely prepared in this country. Improvements have also been effected in the manufacture of T.N.T. and picric acid.

Department of Coal Gas and Fuel Industries.

In another department (Coal Gas and Fuel Industries) the testing of coal gas by-products, such as toluene, required for explosive works is systematically undertaken. This department has also undertaken for the Government the sampling and testing of high explosives manufactured in the district, and this work was in progress on the occasion of the visit. It is of interest to recall that the Livesey Professorship, held by the head of this department, was initiated as a memorial to Sir George Livesey, and the department is in connection with an Advisory Committee, the members of which are nominated jointly by the Institution of Gas Engineers, the Society of British Gas Industries, and the University. Apparatus is provided for high temperature measurements, the compression and liquefaction of gases, furnace work with high and low pressure gas and air, &c.

The visitors were next entertained at the Hotel Metropole as guests of the Leeds Luncheon Club, when an address was given by Mr. H. A. L. Fisher, M.A., LL.D., Vice-Chancellor of Sheffield University, on "India and the Empire." Mr. A. J. Mundella (Fellow of the Inst. of Journalists and Chairman of the London District of the Institute) spoke on behalf of the visitors.

Visits to Factories.

The afternoon was devoted to visits to the Leeds Army Clothing Depot, to the factory of Messrs. L. Albrecht and Albrecht, a large wholesale clothing factory, now engaged on the manufacture of Army garments and cartridge bags, and the Cardigan Boot Factory, at present mainly occupied with orders for the Russian and Italian armies. These factories were selected in view of the close relation between the processes of manufacture and the work of the University, and many of the processes seen were of great interest.

At five o'clock the party were entertained to tea by the Lord Mayor (Mr. Chas. Lupton), who gave a short address of welcome, in the course of which he traced the development of some of the most important industries of the city. Mr. F. Bourne Newton replied on behalf of the visitors, who afterwards left for Sheffield by the Midland train.

The Visit to Sheffield.

On arrival at the Grand Hotel, Sheffield, the party were met by Mr. H. A. L. Fisher (Vice-Chancellor of the University of Sheffield), and by Professor Ripper, Dean of the Applied Science Department, who presided at the evening meal. The local Press was again represented, and several Sheffield journalists joined the party in their visit to the University next day.

The visitors were received at the University Buildings (Western Bank) by the Vice-Chancellor and several members of the staff. The following is a summary of the Vice-Chancellor's address:—

Address by Mr. H. A. L. Fisher, Vice-Chancellor of the University of Sheffield.

I think it may be of some interest to you if I give you a short sketch of the work of the University.

The Sheffield University is the youngest of all the British Universities. It is 11 years old. But although it is the youngest of the Universities, it started from organisations which existed previously. It was formed really out of the amalgamation of three educational institutions, the Firth College, for Arts and Pure Science, founded 1879, the City Technical School, founded 1886, which has become the Applied Science Department of the University (and which you are subsequently to visit), and the Medical School. It was by the amalgamation of these three institutions that the University College of Sheffield was first formed; and the University College subsequently developed into the University of Sheffield. And the fact of its historical origin is still seen. We have here two great blocks of buildings, the block in which you are seated at present, the Department of Pure Science and Arts, at Western Bank, and when we have seen the laboratories here we shall proceed down to St. George's Square, where you will visit the Department of Applied Science.

Now you have in your hands a memorandum compiled by Dr. Wynne, the Dean of our Faculty of Pure Science, which will give you some idea of the work done in our departments of Pure Science in the University. Of course, like all other Universities, we have been very greatly affected by the war. Primarily, of course, it has meant the depletion of our male students. Then again, it has meant the carrying out of a large number of operations which otherwise it would not have occurred to us to carry out. I think that every one, almost every one, of the departments of the University, has in one way or another been affected by the war. The Chemical Department has been very busy making anæsthetics required by the Army; the Metallurgical Department has been doing confidential work for the Admiralty.

We have been training munition workers from quite early in the course of the war, for it became clear that it was desirable to increase the number of such workers. More than 1,000 persons have been trained in the use of the lathe for the purpose of the armament works at Sheffield.

Then again, we have established in the University a very successful Hospital Supply Depot, not only for the making of bandages of all kinds for the hospitals, but also for the making of crutches and surgical instruments, and this Hospital Supply Depot has been supplying hospitals in England, in France, in Salonika, and at Alexandria, and has proved to be of the utmost value.

You will visit very shortly our Medical Department. And I am going to put into your hands a memorandum drawn up by Dr. Leathes, our Professor of Physiology, and a most eminent physiologist, which will give you some idea of the place and the prospects of the medical school in Sheffield. The medical school is at present a very young school. It is, I think you will agree, admirably fitted up, so far as its laboratories are concerned, and I foresee a very great future for the medical school in this University, not only by reason of the excellence of the equipment we have been able to provide, but also by reason of the fact that we have in the Sheffield Hospitals a mass of clinical material available. The Sheffield industries produce peculiar types of dust disease which are well worth the investigation of men of science. And we have this great advantage, at any rate, to start with, that owing to the fact that the school is at present somewhat short of pupils, the students are able to receive more individual attention here than is the case in the crowded schools of London or Edinburgh. Further, the school is admirably adapted for the training of women students who have here just the same privileges as the men.

Now I need hardly point out to you, gentlemen, who know so much about the scientific and technical study of the work of the Universities, how important the science of chemistry is for the industries of Sheffield. It is the basis of the steel industry. And I think it is significant of the close connection which exists between the industry and the University that only the other day I had an application from one of the greatest of Sheffield steel firms, asking us whether we could not provide a compendious course in inorganic chemistry which would enable the chemical laboratories of our great city industries to receive an almost immediate supply of female labour sufficiently trained to carry on the work of the laboratories. We have, of course, responded to that appeal, and these courses will be instituted.

Then again, we have established, since the war began, a Scientific Advisory Committee in the University — a Scientific Advisory Committee for the purpose of solving problems submitted to us by manufacturers of Sheffield and its neighbourhood, and a very large number of cases have come before our Scientific Advisory Committee, and have been dealt with in a satisfactory manner.

It is sometimes thought that the war has necessarily suspended University development. It has done so in some directions in this University, but we have embarked upon a scheme during the war which is going to be of very great value to the country. We have established an Institute of Glass Technology. Now, gentlemen, you probably know that South Yorkshire is the seat of a very great part of our national glass industry. It is true that it is chiefly the glass bottle industry, but you will all be aware that Sheffield is also the home of the silver trade, and that silver and glass are natural allies. And it seemed to us, therefore, that the time has come for the University to take up the question of glass technology, because, gentlemen, it is a very striking fact that until the war there was no scientific teaching of glass technology in any one of our technical institutions in this country. Consequently the University took the matter up, and in view of the strength of the existing equipment in metallurgical and engineering, each of which is a science auxiliary, with every prospect of success. It has received promise of support from the Yorkshire Glass Association. We have promises of support also from the Advisory Committee of the Privy Council. We have purchased a site and we are in the course of erecting buildings, and we hope that before Christmas the new Glass Institute will have been erected, and that it will be undertaking important optical problems for the Ministry of Munitions. We are in close touch with the Ministry of Munitions, and we have therefore their full support and encouragement—in fact, they have communicated to us a considerable number of urgent optical problems which they desire us to take in hand.

But we have progressed in other directions. We have founded a Lectureship in Russian. And in view not only of the existing connection between the great Sheffield armament firms in Russia, but in view also of the prospective developments of British industry in Russia,

it is obviously of the greatest importance that the knowledge of Russian should be diffused in this country. Our Russian Lecturer is already at work, and a very considerable number of pupils have come forward in order to learn the language.

At the beginning of this war it was, as you are aware, a very important function of every University to attempt to enlighten the public as to the true causes of the war and as to the necessity for a great national effort, and accordingly in this University a War Lectures Committee was established in order to carry out patriotic propaganda and educational propaganda in Sheffield and its neighbourhood. A large number of lectures were delivered in Sheffield by eminent specialists, who were invited down to the University. And not only were these formal addresses given but a considerable number of short addresses, partly of an educational character and partly of a recruiting character, were given in the town of Sheffield and in the villages around Sheffield, and in the dinner-hour at the great Sheffield works. And I believe that propaganda had a very powerful effect in directing public opinion in Sheffield and its neighbourhood in the right course.

Now, gentlemen, I think perhaps we had better proceed to the inspection of some of our laboratories. I ought perhaps to say that you will observe a good number of class-rooms, at present occupied by somewhat juvenile persons, who are not members of the University, but who are members of the City Training College, an institution to whom we have extended our hospitality, owing to the fact that their buildings have been taken over for the medical purposes of the Army.

Subsequently a few remarks were made by Ald. A. J. Hobson, the Treasurer of the University, who stated his conviction of the great value of the work done at the University in encouraging the applications of science to industry, which fully justified the previous expenditure incurred. He believed that the Press could exert a great and valuable influence in bringing the importance of this matter home to the nation.

Chemical and Medical Departments.

The visitors then passed through the Chemical and Medical Departments under the guidance of the Dean of the Pure Science Department, Dr. Wynne. One excellent feature of these lecture-rooms and laboratories is the ample provision of daylight and the scrupulously clean and orderly arrangements. The laboratories are exceptionally well-equipped for microscopic and photographic work, and the department is also fortunate in having the nucleus of a well-stocked museum.

At the conclusion of this part of the visit a few words were said by Mr. Leon Gaster, who pointed out that part of the work carried on in this department appeared to be closely related to that undertaken at the Institute for the study of Industrial Diseases, under the supervision of Dr. I. Devoto, of Milan, which he understood was the first institution of this kind to be organised exclusively for such researches. The Institute was supported by the insurance companies, and the money expended on the study of such diseases and their prevention had been most profitably employed. Mr. Gaster also referred to the important step taken by the University in establishing a Department for the Study of Glass Technology, and expressed the hope that it would include in its sphere of action the study of illuminating glassware.

Engineering and Metallurgical Department.

The party then passed to the Engineering and Metallurgical Departments. Here they were addressed by Dr. Ripper, who gave some instances of the very valuable special researches undertaken for various Government Departments in connection with the war. The buildings at St. George's Square form the headquarters of the Sheffield Munitions of War Committee, and the technical resources of the department have been utilised on a large scale by the Authorities. In addition, advice has been given by the University on many points that have arisen since the outbreak of war in connection with various steel industrial operations, such as the hardening and tinning of steel, polishing of razors, contact production of sulphuric acid,

torsion testing, etc., while the Department of Geology has been engaged in searching for a substitute for the Belgian sand used in glass manufacture.

The visitors were conducted over several of the laboratories where interesting testing and metallurgical work is in operation. While steel and iron work forms the chief item, all the chief industrial operations in connection therewith being reproduced on a small scale, a non-ferrous department has recently been added, and has already done good service in experiments on the production of cupro-nickel, required in munition work. The department has specialised steel microphotography. It is stated that of 32 recent contributions to the micrography of steel, 29 emanated from the laboratory of the University.

Visit to Factories.

After leaving the University a visit was next paid to the Atlas Works of Messrs. John Brown and Co. Although it was naturally only possible to pass rapidly through a small section of the works, the visitors were much impressed by the vastness of the operations carried on, and the large area covered. A short time was spent in the research laboratory, where an account of the work undertaken was given by Dr. Hatfield, and the party were then entertained to luncheon by the Directors. It had been anticipated that the Master Cutler (Mr. W. H. Ellis) would preside, but in his unavoidable absence in London the chair was taken by Mr. A. Willis Dixon, the General Works Manager and Director. Among others who were present were the Vice-Chancellor, Dr. Ripper, and Alderman A. J. Hobson.

Mr. Dixon read some remarks that Mr. Ellis had prepared on the subject of the Sheffield Steel Industry. Some people, he said, were too apt to assume that Germany was more diligent in applying scientific methods to steel making than we had been. In some things this might be so, but, speaking generally, the importance of scientific method was fully appreciated by the great steel firms in Sheffield; their managers were trained men, and they were constantly carrying out experiments and endeavouring to make improvements. Mr. Dixon added that Sheffield was the cradle of the steel industry. Of the 28 great discoveries made in the steel world, 24 had come from within the British Empire, while Germany could claim but one. Finally, Mr. Dixon remarked that the firm were also strong believers in hygienic and satisfactory working conditions; cleanness spelled efficiency, and lofty, well-ventilated and well-lighted shops meant that the working man could give a better return for his wages. On this point working men and employers were in full accord.

Mr. Gilbert Wood (Fellow Inst. Jour. and Vice-President of the Inst. of Journalists), and Mr. L. Gaster (Fellow Inst. Journ. and Chairman of the Circle), expressed the thanks of the visitors, who were afterwards taken over a part of the shell factory of Messrs. Thos. Firth and Sons. Here again operations on a tremendous scale were witnessed, shells of every kind, both for naval and land work, being poured out in an endless stream from long rows of shops (many of them, it was remarked, standing on what were green fields only a few months ago). A feature of these works was the employment of women operators, many of whom were undertaking, in a most workmanlike manner, tasks which before the war would invariably have been assigned to men.

The party left Sheffield by the night train for London, much impressed by the very active part taken by the Universities in the life of Leeds and Sheffield, and their intimate relations with the industries of these thriving cities. Here, at all events, the application of science to industry is being seriously considered and the preparations that are now being made should bear good fruit in the future.

Reference should also be made to the co-operation of the local Press in both cities, which, by the presence of its representatives, not only accorded its welcome to the visitors but signified its appreciation of the excellent work which the Universities of Leeds and Sheffield are now doing.

GAS AUTHORITIES AS SUPPLIERS OF ELECTRICITY.

An interesting paper on the above subject was read by Mr. J. W. Napier at the annual meeting of the North British Association of Gas Managers in Edinburgh last September.

Mr. Napier, after mentioning cases in which gas companies had been granted Parliamentary powers to supply electricity (such as the Tottenham District Light, Heat and Power Co.), described the conditions prevailing in Alloa, where both gas and electricity are supplied by the Corporation.

In the past, owing to various unsatisfactory conditions, the supply of electricity did not prove remunerative, the deficit in this section being met out of the profits from gas; this was chiefly due to the small supply of electricity for power, and in 1910—1914 much larger plant was installed, in the form of electric generators driven by direct coupled gas engines supplied from a producer gas plant. The system, representing an arrangement satisfactory alike to the gas and electrical departments, has proved very satisfactory in practice, and, from the standpoint of coal-saving, is regarded as of national importance. A scheme for a producer gas plant of the Mond type, with recovery plant, has been now decided upon. This will supply gas to both stations—to the gas works for heating retorts, and to the electricity supply station for driving the gas engines. The production of ammonia as a by-product should thus be carried on under efficient conditions.

For many years Alloa has enjoyed an exceptionally low rate for gas (in pre-war times 2s. 1d. to 2s. 4d. for lighting, and 1s. 4d. to 1s. 10d. for power), and the consumption has steadily risen to 150,000,000 cubic feet.

A corresponding improvement in the electrical side of the business is now to be noted, the annual output having increased from 100,000 units in 1910 to 800,000 units in 1916. Mr. Napier states that there is no collision of interests in supplying both forms of energy. "Consumers demand whatever form of energy is most convenient and best suited to their requirements, and they are supplied accordingly. A showroom was recently opened in which there is exhibited lighting, heating, and cooking apparatus for both gas and electricity."

In Mr. Napier's opinion the view that encouraging the supply of electricity lessens the demand for gas is quite incorrect. The use of gas is far from having reached its limit in any city, and the addition of electrical business does not mean that this is abstracted from the gas department. On the contrary, the recognition that in certain cases electric lighting is most convenient or electric motors preferable to gas engines, enables business to be added that might not otherwise be secured, and, as the Corporation owns both supplies, there is no conflict of interests.

Mr. Napier concludes his paper as follows:—

"From the evidence now adduced it may be fairly claimed that the co-existence of gas and electricity supply under one control is at once a practical and commercial proposition. The fresh field of business will appeal chiefly in the case of towns where there is at present no electricity supply. It is my settled conviction that what is required of the gas industry of to-day is a broadening of the basis of its function as suppliers of the public need for energy—gas and electricity. There is small doubt but that gas companies, if they do not prepare the way, will be met in the near future with competition where there is no electricity supply at present. It is a true indication of strength and vitality when an industrial business can comprehend the issues that lie in front of it, and having done so, prepare accordingly."

A LIGHTING CODE IN PENNSYLVANIA.

In a recent issue of the *Lighting Journal* (U.S.A.), Mr. C. E. Clewell mentions that the Pennsylvania Department of Labour and Industry has adopted a Lighting Code for factories, mills, and other work-places, to become operative on July 1st, 1916. The adoption of this code is of special interest as one of the first tangible results of the work of the American Illuminating Engineering Society in the United States, whose "Code," issued last year, is closely followed in that drafted by the Pennsylvania Industrial Board. This is stated to be the first occasion on which factory lighting regulations in the United States have been based on the intensity of illumination required for various classes of work. The minimum intensity for five distinct classes of work is given as follows:—

FOOT-CANDLES ON THE WORK.

	Minimum.	Ordinary Acceptable Practice.
1. Roadways and yard thoroughfares ..	0·05	0·05—0·25
2. Stairways, passage-ways, aisles, storage spaces, &c. ..	0·25	0·25—0·50
3. Rough manufacturing operations, such as foundry work, rough machining, rough assembling, rough bench work ..	1·25	1·25— 2·50
4. Fine manufacturing operations, such as fine lathe work, pattern and tool making, light coloured textiles, tobacco manufacture	3·50	3·50—6·00
5. Special cases of fine work, such as watch-making, engraving, drawing, work on dark coloured textiles	5·0	10·0—15·00

Other regulations require in general terms that (1) glare either from lamps or unduly bright surfaces, producing eye-strain, are to be avoided ; (2) exposed bare lamps shall not be used except when they are out of the ordinary line of vision, and lamps should be suitably fitted to minimise glare ; (3) lamps must also be so arranged as to secure good distribution of light on the work, avoiding objectionable shadows and sharp contrasts in intensity ; (4) emergency lighting shall be provided in all work space, gangways, stairways, passage-ways, and exits ; such lights shall be so arranged as to insure their reliable operation when, through accident or other cause, the regular lighting is extinguished ; (5) switching and controlling apparatus shall be so placed that at least pilot or night lights may be turned on from the main point of entrance.

In the course of the article an abstract of the chief recommendations of the Report issued by the Home Office Departmental Committee in this country is also given. The conclusions embodied in this Report are in good general agreement with the requirements now being framed in the United States, and it is evident that the movement towards better industrial illumination is making steady progress in both countries.

The *American Machinist*, in congratulating Pennsylvania on taking the initiative in making provisions for the adequate lighting of factories, remarks that in regulations of this kind where pioneering work is involved, the rulings must not be looked upon as final, but as representing what may be expected in the present state of illuminating engineering. No doubt they will require modification in course of time. Meantime it is of interest to ask," What State will be next?'

LIGHTING OF VEHICLES.

NEW ORDER UNDER THE DEFENCE OF THE REALM ACT.

AN Order under the Defence of the Realm Act (No. 713, 1916), relating to the lighting of vehicles in places outside the Metropolitan and City of London Police Districts, was issued on October 6th.

Part I. directs that every vehicle on any street, highway, or road to which the public have access must, between half-an-hour after sunset and half-an-hour before sunrise carry lamps as follows:—

(A) At the front, a lamp or lamps displaying to the front a white light. Except in the case of a bicycle or tricycle (other than a motor tricycle) one such lamp must be placed on the extreme off or right-hand side of the vehicle: if a second lamp is carried it must be placed in the corresponding position on the extreme near or left-hand side of the vehicle; and

(B) At the rear, a lamp displaying to the rear a red light. The lamp carried for this purpose on any vehicle other than a bicycle or tricycle must be placed on the off or right-hand side of the vehicle.

Hand carts and wheeled bicycles (near the edge of the roadway) need only carry a white light to the front and a red light to the rear.

On and after January 1st, 1917, two lamps displaying to the front a white light must be carried on all vehicles (except bicycles and tricycles).

Lamps must be properly trimmed, lighted, and attached so that the light from each lamp is visible in the prescribed direction for a reasonable distance without obstruction.

Part II. requires that headlights on tramcars must not be of a greater brightness than is necessary for the public safety, and the inside lights of tramcars and omnibuses must be reduced, shaded, or obscured so that no more light is used than is necessary to enable fares to be collected, and the light is prevented, so far as practicable, from being visible from outside.

The following specific restrictions relating to the headlights of vehicles and motor-cars are of special interest:—

1. The use of headlamps on motor cars is prohibited and not more than two lamps showing a light to the front may be used on any vehicle, except that headlamps not exceeding two in number may be used in addition to the side-lamps carried in compliance with Part I. of this Order, if the sidelamps burn only candle or oil and have not lens fronts. All such headlamps must comply with the later requirements of this Order.

2. In electric lamps the bulb must not exceed 12 watts, or give in use a greater candlepower than the 12-watt (12 nominal candlepower) bulb as standardised for sidelights by the Engineering Standards Committee (Report No. 69).

3. In acetylene lamps the burner must not consume more than 14 litres ($\frac{1}{2}$ cubic foot) per hour.

4. In oil lamps only one burner may be used: the wick must not exceed three-quarters of an inch in width.

5. In electric and acetylene lamps the diameter or longer side of the front glass, according as it is circular or rectangular, must not exceed 6 inches, or the front glass must be permanently obscured so that no light can pass except through a central portion which does not exceed $4\frac{1}{2}$ inches in diameter.

6. The front glasses of (1) all electric and acetylene lamps, and (2) lamps burning candle or oil with lens fronts, must be obscured—

(A) In electric lamps, with at least one thickness of ordinary white tissue paper;

(B) In acetylene lamps and in candle and oil lamps to which this paragraph applies, with at least one thickness of ordinary white tissue paper or with paint, ground glass, or a disc of some other uncoloured material so that the obscuring effect produced is not less than that of one thickness of ordinary white tissue paper.

The paper, paint, or disc must cover the whole of the portion of the front glass through which light can pass and must not be wetted, oiled, varnished, or treated in any other way so as to increase its transparency.

Side panels of electric and acetylene lamps, except small red or green side panels, must be covered over with some completely opaque material. This paragraph shall not apply to the lamp displaying a red light carried at the rear of a vehicle.

In Part III. the following further restrictions on the use of lights on vehicles have effect in certain cities, boroughs, and districts (a list of which is given):—

1. Headlamps on motor cars must not be used, and all other lamps to which paragraph 6 of Part II. of this Order applies must be further obscured with a cap or disc* constructed and attached as follows:—

(A) The cap or disc must be made of completely opaque material, must fit near to the front glass of the lamp and must cover it so as to prevent the passage of light except through the apertures cut as provided in paragraph 1 (B) below.

(B) The apertures must be circular, half an inch in diameter; they must be six in number and spaced approximately evenly round the disc so that no portion of any of the apertures is nearer the centre of the disc than one-quarter the diameter of the effective front of the lamp, if it is circular, or one-quarter the longer side, if it is rectangular.

2. The reflectors of all other lamps burning candle or oil which are provided with a reflector and have a front glass exceeding 3 inches in diameter, must be covered with some non-reflecting material, in lieu of using the cap or disc described in paragraph 1.

It is to be noted that Parts II. and III. in this Order are not to apply to the lamps used on any fire brigade vehicle when such a vehicle is actually proceeding to a fire.

* This cap or disc is illustrated in a sketch in the Second Schedule to this Order.

CATTLE DROVERS TO CARRY LIGHTS.

We notice that in a further Order, under the Defence of the Realm Act it is stated that on and after October 22nd, any persons driving or leading horses, cattle, sheep, &c., along public thoroughfares during the period between half-an-hour after sunset and half-an-hour before sunrise, must carry a lamp showing a white light to front and rear. Where there are not more than four animals the light is to be carried by the person leading them. If there are more than twenty head of cattle or more than one hundred sheep, goats, &c., a second lamp must be provided.

PROBABLE INCREASE IN PUBLIC LIGHTING IN EDINBURGH.

We understand that a series of experiments has been made in Edinburgh with a view to improving the public lighting, so as to comply with the requirements of the Authorities, and make better provision against possible dangers and accidents. The experiments are in the direction of using low candlepower lamps at frequent intervals, either 100 c.p. lamps on alternate lamps or 50 c.p. lamps on all of them. The latter arrangement which gives an illumination which, though weak as compared with that prevailing in pre-war days, is continuous from lamp to lamp, seems preferable. It is hoped that the Authorities will accept the view that this degree of increase can be granted with safety.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

EMERGENCY LIGHTING ON BOARD SHIP.

With reference to the article that appeared in our last issue on "Illumination in the Navy" (p. 281), our attention is drawn to the question of emergency lighting circuits.

We are informed that in view of the new requirements of the International Shipping Association a special Automatic Emergency Lighting Plant has been designed by Messrs. R. A. Lister and Co., Ltd. (known as the "S.O.S. Lister-Bruston"). The special features claimed for this plant are :—

(1) The automatic starting immediately the main ship's supply falls below a predetermined point.

(2) Automatic daily testing. The plant starting up at any predetermined time, and running for any period that may be desired, at the end of which it automatically stops.

(3) Should the plant be out of working order or the engine not be running up to its proper speed a red lamp lights up in any part of the vessel where it may be required ; or an audible indication can be arranged.

(4) An automatic change-over-switch is fitted on the switchboard and any circuits may be connected to the emergency lighting system and automatically changed over from the main ship's supply when the automatic set starts up.

In addition there is the advantage claimed generally for all Lister-Bruston plant, that only a very small battery outfit is needed ; this is an important consideration on board ship.

We are informed that Messrs. Pass and Seymour (of Syracuse, N.Y., U.S.A.) have made arrangements with **Messrs. The Benjamin Electric, Ltd.** (in Rosebery Avenue, London, E.C.), to represent them in the sale of P. & S. Handy Electrical Wiring Devices for England, Ireland, Scotland, and Wales.

Some of these special devices, including the Shurlock Socket, are described in an attractive booklet issued by Messrs. Pass and Seymour, of which full particulars can be had on application to Benjamin Electric, Ltd.

Imperial Light, Ltd., are issuing a leaflet descriptive of the "Imperial" Flare and Hand Lamps in various portable patterns. We understand that since the outbreak of war there has been an enormous demand for such portable acetylene lamps which, besides being useful for many industrial uses at home, have many military applications.

PUBLICATIONS RECEIVED.

Can you believe your eyes ? (address at the opening of the Course in Physiology in the University of Manchester) ; Health, Fatigue and Repose (Lady Priestly Memorial Lecture delivered in London, Nov. 27th, 1913) ; *Curiosities and Defects of Sight (Lecture delivered before the British Association,* 1915).

THE above are a series of lectures delivered at various times by Dr. William Stirling, Professor of Physiology and Histology in the University of Manchester, and now reprinted in booklet form. Many of the curiosities of sight described are very interesting and are illustrated by some ingenious devices. Professor Stirling discusses the production of mental and muscular fatigue, and mentions several forms of apparatus (such as the "ergograph") by which it can be tested. In these days when conditions in factories are being so closely studied, the dissemination of such information in a popular and readable form is a useful service.

The Stability of Vulcanised Rubber and the Optimum Cure ; the Function of Litharge in the vulcanisation of Rubber by Henry P. Stevens (reprinted from the Journal of the Society of Chemical Industry).

Transactions of the Illuminating Engineering Society (Edison Decennial Number, August 30th, 1916).

THIS number is a particularly attractive one, a feature being the series of colour-reproductions, illustrating the novel lighting arrangements at the Panama-Pacific Exhibition. While in the present circumstances decorative lighting is naturally receiving little attention in this country, the novel and interesting methods now being introduced in the United States should not be entirely lost sight of ; they may furnish us with some useful hints for the future.

Another feature is the Address of Welcome addressed to Mr. Thomas Alva Edison, on the occasion of his being created an Honorary Member of the Illuminating Engineering Society, U.S.A. The number is also of interest as marking the Tenth Anniversary of the Society's existence.

PERSONAL.

We are informed that Lieut. A. R. Courtenay, until recently acting-manager of the Publicity Department of the General Electric Co., Ltd., has been promoted to full lieutenant, after nearly nine months' service in Egypt and Salonica. He was invalided home with dysentry, but we are glad to hear that he is now once more in good health.

Lieut. Courtenay was well known in the electro-journalistic sphere, and the above will be welcome news to his many friends.

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LANTERNS AND REFLECTORS FOR INDUSTRIAL LIGHTING.

An attractive leaflet issued by the **Wardle Engineering Co., Ltd.** (196 Deansgate, Manchester), illustrates the importance of good industrial lighting. Sketches are presented showing that the use of appropriate units for lighting desks, docks and wharves, over travelling cranes, &c., and attention is drawn to the importance attached to factory lighting by the Government, as an indication that this matter deserves earnest study at the hands of manufacturers.

Among the advantages claimed for scientific light control are :—Less danger ; less fatigue for workers ; happier workpeople ; better work ; greater production ; less cost for current ; greater profits.

A booklet issued by **Engineering and Arc Lamps, Ltd.** (Sphere Works, St. Albans, Herts), also deserves notice. A number of special fittings for use with half-watt lamps are shown, among them being several (the "Britannia," "Clyde," &c.) which seem particularly adapted to industrial lighting. In our last number we mentioned a similar line of fittings brought out by Crompton and Co., and we are glad to see that the design of half suitable lanterns and reflectors for half-watt lamps is now being taken up very generally by manufacturers of electric lighting appliances.

Another novelty brought out by Engineering and Arc Lamps, Ltd., is the "Nevaknot" adaptor, which, as its name implies, is claimed to prevent inconvenient twisting, knotting and tangling of flexible wires.

SHADED LIGHTS.

In view of the demand for proper shading devices in order to comply with the Lighting Regulations it is of interest to notice that special metal reflectors for this purpose are being supplied by **A. E. Podmore and Co.** (34 Charles Street, Hatton Garden, E.C.).

At the present time there is undoubtedly a need for workmanlike metal shades of this kind for gas lamps. Makeshift devices of paper and cardboard give unsatisfactory lighting conditions and are sometimes actually dangerous. The reflectors in question have a polished interior surface and serve the double purpose of screening the lights and directing the rays inwards where they are chiefly needed.

AMERICAN ASSOCIATION OF GAS INDUSTRIES.

We notice that, according to the *Gas Age*, a new organisation, The Association of American Gas Industries, is coming into existence in the United States. Among the objects of the new Association are the establishment of more reasonable, equitable and uniform contract conditions between its members and the Corporations that purchase their product, and the promotion of a higher appreciation on the part of Corporations of the value of the services rendered by its members.

We are informed that Mr. F. J. Roden has resigned his position as Director of The Electrical Supplies Co., and that for the present the direction and control of the business will be vested in the Managing Director, Mr. E. C. Beman.

The Illuminating Engineering Society.

(FOUNDED IN LONDON, 1909.)

NOTICE OF NEXT MEETING.

The opening Meeting of the Society will take place at the House of the Royal Society of Arts (18, John Street, Adelphi, London), at **5 p.m.,** on **Friday, December 15th**, when an Account of Events during the Vacation, including some suggestions regarding ***War Economies in Lighting,*** will be delivered by Mr. L. GASTER (Hon. Secretary).